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Solar Energy Potential and Applications in Myanmar

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***Abstract*—**Energy consumption is one of the indices in determining the levels of development of a nation. Therefore, availability of energy supply to all sectors of life in any country is crucial for its development. These exists shortage of all kinds of energy, particularly electricity which is badly needed for economic development. Electricity from the sun which is quite abundant in most of the developing countries is used in rural areas to meet basic electricity needs of a rural community. Today's electricity supply in Myanmar is generated by fuel generators and hydroelectric power plants. However, far-flung areas which are away from National Grids cannot enjoy the electricity generated by these sources. Since Myanmar is a land of plentiful sunshine, especially in central and southern regions of the country, the first form of energy- solar energy could hopefully become the final solution to its energy supply problem. The direct conversion of solar energy into electricity using photovoltaic system has been receiving intensive installation not only in developed countries but also in developing countries. It is mainly intended to present solar energy potential and application in Myanmar. It is also wanted to get the benefits of using solar energy for people in remote areas which are not yet connected to the national grids because of the high price of fossil fuel.

***Keywords*—**Electricity supply in Myanmar, National Grids, solar energy.

I. Introduction

THE provision of electricity to rural areas derives important social and economic benefits to remove communities throughout the world. The potential for PV-powered rural applications is enormous.

The geographical location of Myanmar is between latitude 9° 58' N and 28° 29' N and longitude 92° 10' E and 101° 10' E. Myanmar has a tropical monsoon climate. The cooler, dry season lasts from November to April and the hotter, wet season from May to September or October.

Differences of altitude within the country, and the extent of exposure to the rainy southwest monsoon, are the main factors responsible for differences of climate within Myanmar. The weather is hottest from March-May, before the onset of the heaviest rains.

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Temperatures are cooler in the mountains, but the weather at places below 4000ft (1200m) is hot and tropical in most of the year. In coastal areas, conditions can be uncomfortable because of high humidity. Sunshine is plentiful during the dry season, averaging 7 to 10 hours a day. During the rainy season the weather is cloudier and daily sunshine amounts average only 3 to 4 hours a day. Total area or total square miles of Myanmar is 261228. The radiated heat energy from the sun on to the earth converted to horse power is 469×10^{11}. Therefore, total approximate horse power on total area of Myanmar is calculated to be 123×10^{10}, that is the sun's radiated heat power.

The following solar energy technologies can be successfully propagated: solar cookers; solar water heating systems for industrial application; solar distillation units for battery charging; solar photovoltaic systems for water pumping, battery charging, and power supply to children's hospitals for operating vital equipment. Solar air driers can be used for agricultural and industrial products [1].

II. Solar Energy Potential in Myanmar

A. Solar Radiation Data of Myanmar

MEPE (Myanma Electric Power Enterprise) experimental measurements indicate that irradiation intensity of more than 5 kWh/m^2/day was observed during the dry season.

Since the reliability of these systems is paramount, the sizing method used is based on radiation data for the worst month of the year rather than on the average daily irradiation over the year. In addition to ensure system operation even over periods of lower solar radiation than predicted from the average yearly values, the sizing often uses data for the worst year in ten [2].

In practical applications, solar cells do not operate under standard conditions. The two most important effects that must be allowed for are due to the variable temperature and irradiance. Temperature has an important effect on the power output from the cell. Irradiance is directly proportional to the short-circuit current of a solar cell [2].

Therefore, the recoded solar intensity around Yangon and some part of the country are given in Table I and II [3]. Fig. 1 is shown solar radiation data corresponding to the selected cities.

TABLE I
MONTHLY AVERAGE RADIATION (KWH/M^2/DAY) RECORDS OF SELECTED CITIES

No	Location/ Cities	Jan	Feb	Mar	Apr	May	Jun
1	Monywa	4.45	5.63	6.11	6.47	6.09	5.45
2	Meikhtila	4.55	5.64	6.25	6.64	5.98	4.97
3	Magwey	4.90	5.52	6.06	6.50	5.91	5.08
4	Lashio	4.45	5.71	6.07	6.07	5.71	4.91
5	Mandalay	4.50	5.65	6.06	6.33	5.97	5.45
6	Pyay	4.79	5.88	6.12	6.19	5.61	4.45
7	Myitkyina	4.16	5.05	5.56	5.82	5.48	4.07
8	Sittwey	4.65	5.68	5.84	6.49	5.42	3.78
9	Yangon (Kaba Aye)	4.92	5.77	6.04	6.40	4.92	3.70
10	Dawei	5.06	5.82	6.00	6.29	4.85	4.68
11	Kauthaung	5.07	5.52	5.93	6.09	4.71	3.61

TABLE II
MONTHLY AVERAGE RADIATION (KWH/M^2/DAY) RECORDS OF SELECTED CITIES

No	Location/ Cities	Jul	Aug	Sep	Oct	Nov	Dec
1	Monywa	4.93	4.66	4.75	4.37	4.11	4.05
2	Meikhtila	4.84	4.79	4.79	4.55	4.21	4.05
3	Magwey	4.83	4.79	4.90	4.69	4.16	4.31
4	Lashio	4.34	4.29	4.52	4.23	4.00	3.84
5	Mandalay	4.88	4.64	4.70	4.34	4.07	3.99
6	Pyay	4.22	4.21	4.56	4.58	4.35	4.28
7	Myitkyina	3.69	4.18	4.31	4.15	3.83	3.78
8	Sittwey	3.54	3.73	4.40	4.70	4.29	4.31
9	Yangon (Kaba Aye)	3.41	3.50	4.05	4.63	4.52	4.47
10	Dawei	3.42	3.33	4.04	4.86	4.94	4.84
11	Kauthaung	3.30	3.27	3.85	4.72	4.70	3.54

B. Limitation of Solar Energy in Myanmar

The solar electric power can be improved the quality of life for people living in insolated areas. The most important thing is to keep the power system simple and dependable. Here, power and light supplied with solar system are now available for studying, working and for just playing around in rural areas.

As Myanmar is situated in the southeastern part of the Asian Continent, it enjoys abundant sunshine all year around, especially in the Central Myanmar Dry Zone Area; Potential available Solar Energy of Myanmar is around 51973.8 Terea Watt-hour per year. Use of solar energy is also in the very initial stages. Due to the expensive initial cost the solar energy is presently in the research and development phase.

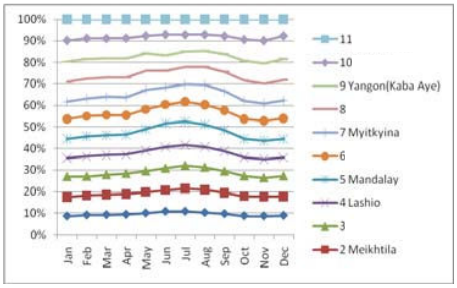

Fig. 1 Solar radiation data corresponding to the selected cities

III. SOLAR APPLICATIONS IN MYANMAR

A. Photovoltaic Current Applications in Myanmar

The current applications in Myanmar are

1. Natha-myaing Village	3.6	kW
2. VAST Station, Mogok	1.8	kW
3. PV System for Computer, Hakha, Chin State	0.3	kW
4. PV System for Radio Telephone Post and Telecommunications	3.00	kW
5. PV Battery Charging Station at Pale, Thongwa Township	0.45	kW
6. PV Water Pumping Stations all over Myanmar, Water Resources Department	40	kW
7. PV powerd Solar Refrigerators under Ministry of Health	50	kW
8. PV powered Rural Health Centers under Ministry of Health	15	kW
9. Private owned PV systems (sold by various companies)[4]	250	kW
10. Yan Myo Aung Village	40	kW
11. Chaung Tha Village	80	kW
12. Other utilizations	50	kW

B. Javascript Solar Position Calculator

Javascript solar position calculator is simply to check for the experiment data. The following Hyper Text Markup Language Form uses the mathematical method described above to calculate a range of solar data at a particular date time. In Myanmar, even a little solar electric power can improve the quality of life for people living in isolated areas. The latitude, longitude and time zone of the described location are simply entered, the required data and time is set, and then the calculate button is selected. The correct time zone to match the longitude of the site should be careful selected. This calculator is used to calculate the Declination, Equation of

time, Solar Altitude, Solar Azimute, Solar Time, Sunrise and Sunset of Mandalay. Thesse results are shown in Table III.

TABLE III
JAVASCRIPT SOLAR POSITION

Input Parameters	
Latitude	22˚
Longitude	96˚
Time Zone	GMT + 4
Month	January
Day	21
Local Time	UT – 8h
Output Results	
Declination	-20.0189
Equation of Time	-11.1095 minutes
Solar Altitude	31.14˚
Solar Azimute	87.13˚
Solar Time	9:33 h
Time of Sunrise	07:13 h
Time of Sunset	16:35 h

C. Location of Water Pumping System in Nantha Myaing Village

Water delivery system of the whole village has been operated by solar electric power supply system for Nantha Myaing village. Nantha Myaing village was situated in Madayar Township of Mandalay Division. According to the radiation records, the monthly average radiation is high at Mandalay within Upper Myanmar. So, Mandalay has chosen the most promising site for the demonstration. Mean insolation data for Nantha Myaing Village is shown in the Table IV.

TABLE IV
MEAN INSOLATION DATA FOR MANDALAY (NANTHA MYAING VILLAGE)

Month	Sunshine Hours	Peak Sun Hours
January	7.6	5.5
February	6.4	5.5
March	4.7	4.5
April	8.7	6.5
May	9.1	6.5
June	8.9	6.5
July	8.5	6.0
August	8.0	6.5
September	5.8	5.5
October	7.0	6.0
November	7.5	6.0
December	4.5	4.5
Annual	7.23	5.8

D. Solar Electric Power System Establishment In Nantha Myaing Village

Two solar photovoltaic power supply system's installation together with successful performance test was completed as scheduled [5].

System I is configurated with 32 numbers of 75 W Siemens Solar modules to run Grundfos SP 3A 10 Submersible Pump. This system is established at pump station I. Thirty two solar modules are installed on four auto tracker stands by dividing our sub arrays with eight modules each mounted. System performance description shows that output power capacity is 2399 W with water pump up capacity of 13254 gallons per day at 180 ft head.

System II is configured with 16 numbers of 75 W Siemens Solar modules to run Grundfos SP 3A 10 Submersible Pump. This system is established at pump station II. Sixteen solar modules are installed on two support structures, and mounted at fix position facing to North direction.

Each mounting structure has eight modules. System performance description shows that output power capacity is 1200 W with water pump up capacity of 4500 gallons per day at 100 ft head.

Previously, eight numbers of concrete tanks and one over head tank are established for village water distribution system.

Among those, two concrete tanks situated at pump station I and II are not operating. At present, those two old concrete tanks are reconstructed. One at pump station II is equipped with two 2" GI pipe lines to two new water taps for water delivery. Two new over head tanks are established at the capacity of 4800 gallons and 2400 gallons each. The larger one constructed with 6 numbers of 8'×4'×4' metal tanks is situated at pump station I. Another small head tank is composed of 3 numbers of 8'×4'×4' metal tanks and which is situated at pump station II [5].

E. Performance

After complete installation of the system I, performance test result shows that water pump up capacity is 13500 gallons per day (8 hrs/day run).

After complete installation of the system II, performance test result shows that water pump up capacity is 7500 gallons per day (8 hrs/day run).

F. Location of Solar Lighting System in Yan Myo Aung Village

In Yan Myo Aung, isolated village India Myanmar border, 110 families are beginning to enjoy the benefits of power and light thanks to solar energy. In this government sponsored program, solar home units had been installed for the entire village. Designed and installed by every home involved in this project is equipped with a fluorescent light switch, wires and connectors and a battery with a discharge protector [7].

G. Location of Solar Lighting System in Chaung Tha Village

The first solar power and wind power in lighting system attached by a diesel engine driven generator project was started at Chaug Tha beach in late 2000. The main task of the project is to lessen the pollution of air and better the environment. By this project solar energy would generate 80 kW and wind turbine would generate 40 kW continuously. In this project, the whole village had been powered by grid connected system [7].

Other utilizations used in Myanmar are solar home system for household electricity in Yangon and other cities, pumping water for irrigation and drinking in Rakhine and Kachin States, electrification for the remote villages for providing street lighting and other community services in Kalay City, telecommunication for the post and telegraph and railways communication network, medical care centre in Kanbauk village, solar clocks in heavy industries, solar cooking in Ngapali beach in Rakhine State and solar road warning at main road and solar traffic light in Yangon.

In Myanmar, even a little solar electric power can improve the quality of life for people living in isolated areas. Dependable power for light, communications, and water can go a long way to improving health, education and the economy in even the most remote villages. The most important thing is to keep the power system simple and dependable. Here, power and light supplied with solar system are now available for studying, working and for just playing around in rural areas [6].

IV. Conclusion

Since Myanmar is a land of plentiful sunshine, solar energy is available around the country. Due to the expensive cost of the solar energy, some can use it. So researchers have also been doing research concerning about solar cells in Myanmar. Researchers have also been doing concerning about solar cells in Myanmar. If Myanmar produce solar cells as a home-made, the prices will be cheaper than we expected. If so, everywhere away from National Grids can enjoy the electricity generated by solar energy. Solar energy is presently in the research and development phase due to the cost.

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